

ISTC Project

In-situ and remote Earth Observation as a tool of sustainable water management and safety issues of transboundary river basins and water bodies

Acronym: EO4WMAN

Participant organizations

Leading organization [Center for Ecological Noosphere Studies](#) of NAS RA (Armenia)

Other participating organizations The International Water Management Institute's (IWMI's) (Uzbekistan)

Kazakh Scientific Research Institute of Water Economy
(*KazSRIWE*) (Kazakhstan)

Foreign collaborators NASA, European space agency (ESA), German Research Center for Geoscience - GFZ (CAWa project), University of Geneva (UNIGE)

Project duration 36 months

Problem statement

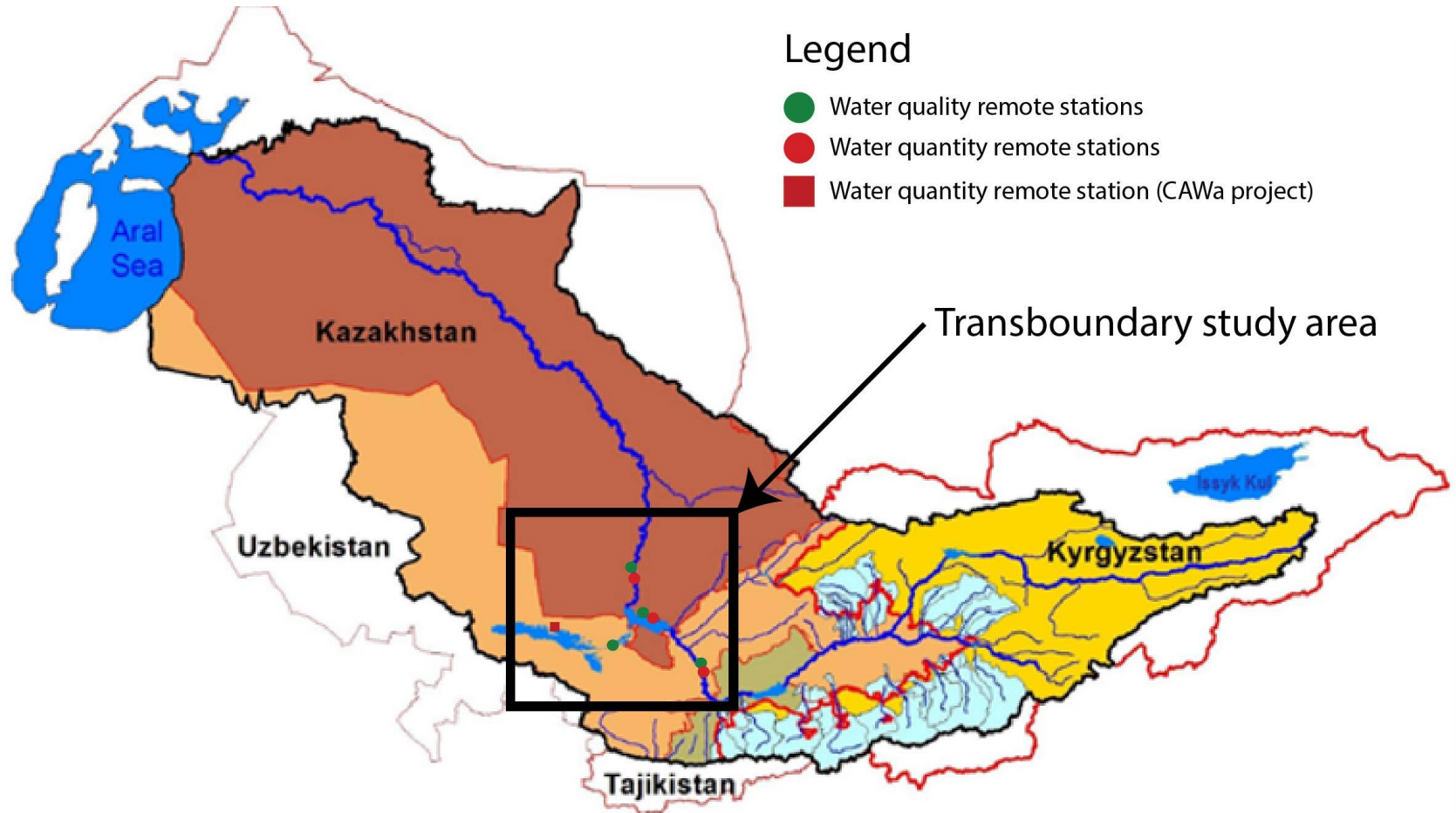
The lack of effective management in the use and development of **transboundary water resources in the Aral Sea Basin** has had severe consequences for the natural environment, the human population, and the economies of the Central Asian countries. The quality of surface water in this region has deteriorated dramatically in recent years. Surface water pollution has reached unprecedented levels, particularly in the Syr Darya river. Faced with these challenges, the Syr Darya river transboundary countries (Uzbekistan, Kazakhstan) are seeking to develop a regime for the **management of transboundary water resources**.

The post-independence upstream shift in water use away from irrigation has created disputes between Uzbekistan and Kazakhstan over **how the region's transboundary waters should be managed**. The ecological use of transboundary waters can be managed through **international multilateral agreements, bilateral agreements or by international customary law**. However when managing transboundary waters, in order to increase the role of relevant agreements and make these more effective, **standardization of methods** of ecological data generation and analysis **escaping physical contacts** are required. This may be achieved through introduction of **In-situ and Remote Earth Observation (EO) Systems**. Use of this technologies substantially improves planning in water management and supports informed decision making from local-to-regional level based on **reliable (objective) information**.

The Project Goal

Development of the Transboundary Water Earth Observation System (TWEOS) for sustainable water management and safety issues of Syr darya transboundary rivers and water bodies allocated in Kazakhstan and Uzbekistan. TWEOS will gather the data from the existing and new installed in-situ sensors (hydrological stations), UAV imagery and open source RS data to prepare and make available all the data needed for modeling ecological state of water in the form of a Web service.

The Syr Darya River Basin and transboundary study area is primarily agrarian, so water bodies (a lake **Aydarkul**, water reservoir - **Shardar**, river – **Syr Darya** middle reach) constitute a complete system, water use conflicts manifesting themselves most acutely. Also, physical parameters of water bodies (width, depth) underpin creation of water EO system through the open-access medium resolution satellite imagery .



CAWA project

- installation of remote automated stations for monitoring water quantity,
- development of RS models for assessing quantitative parameters of water bodies,
- construction of SDSS web portal for data input and dissemination.

Proposed project

- increase the number of automated stations for water quantity monitoring and adding new automated stations for water quality monitoring,
- development RS models for assessing qualitative parameters of water bodies,
- All stations data will be available through CAWa SDSS web-portal.

Scope of Activities

Adopting an integrated approach of monitoring the ecological status of water systems of Syrdarya transboundary river using satellite, UAV and in-situ remote station data.

- Analysis and generalization of the expertise as well as development of an in-situ and remote earth observation data interpretation methodology in joint researches using RS data.
- Definition of water quality and quantity parameters for justification of study areas in Kazakhstan and Uzbekistan.
- Definition of software and information packages needed for studies.
- Development of field schedules (UAV acquisition) and assessment of applicability and purchase of in-situ remote sensors (hydrological stations).
- Installation of in-situ remote sensors in rivers and lakes to generate continuous real-time field data. Data storage and transmission will run automatically, without computer environment, by special devices.
- For SWAT model running data (soil, climate, land cover) collection.

Scope of Activities

Monitoring, assessing and predicting the ecological status of water systems of the Syrdarya transboundary river basin.

- Monitoring quality (dissolved oxygen, temperature, electrical conductivity/salinity, pH, turbidity, nitrogen, chlorides, manganese, sodium, mineralization, chlorophyll) and quantity (variations of levels of lakes, water reservoirs and rivers, river water discharge) parameters in transboundary rivers and lakes by means of existing and new installed in-situ hydrological sensors (Ground-based EO: ROMPS (Remotely Operated Multi-Parameter Stations) and portable data loggers.
- Developing a model of monitoring, assessment and prediction of quality and quantity parameters of rivers and lakes through harmonization of open-access (Landsat 8 and Sentinel 1,2) optical and radar satellite imagery.
- UAV survey of water basin objects using multi-spectral optical cameras.
- Quality assurance and quality control: calibration and validation of the novel developed remotes sensing models (linear, nonlinear) and verification of accuracy of space-and-time prediction.
- Setting up, calibrating and validating a watershed - based SWAT hydrological model in order to analyze the fate of quantity and quality parameters of water systems in the middle reaches of the Syrdarya River basin.

Scope of Activities

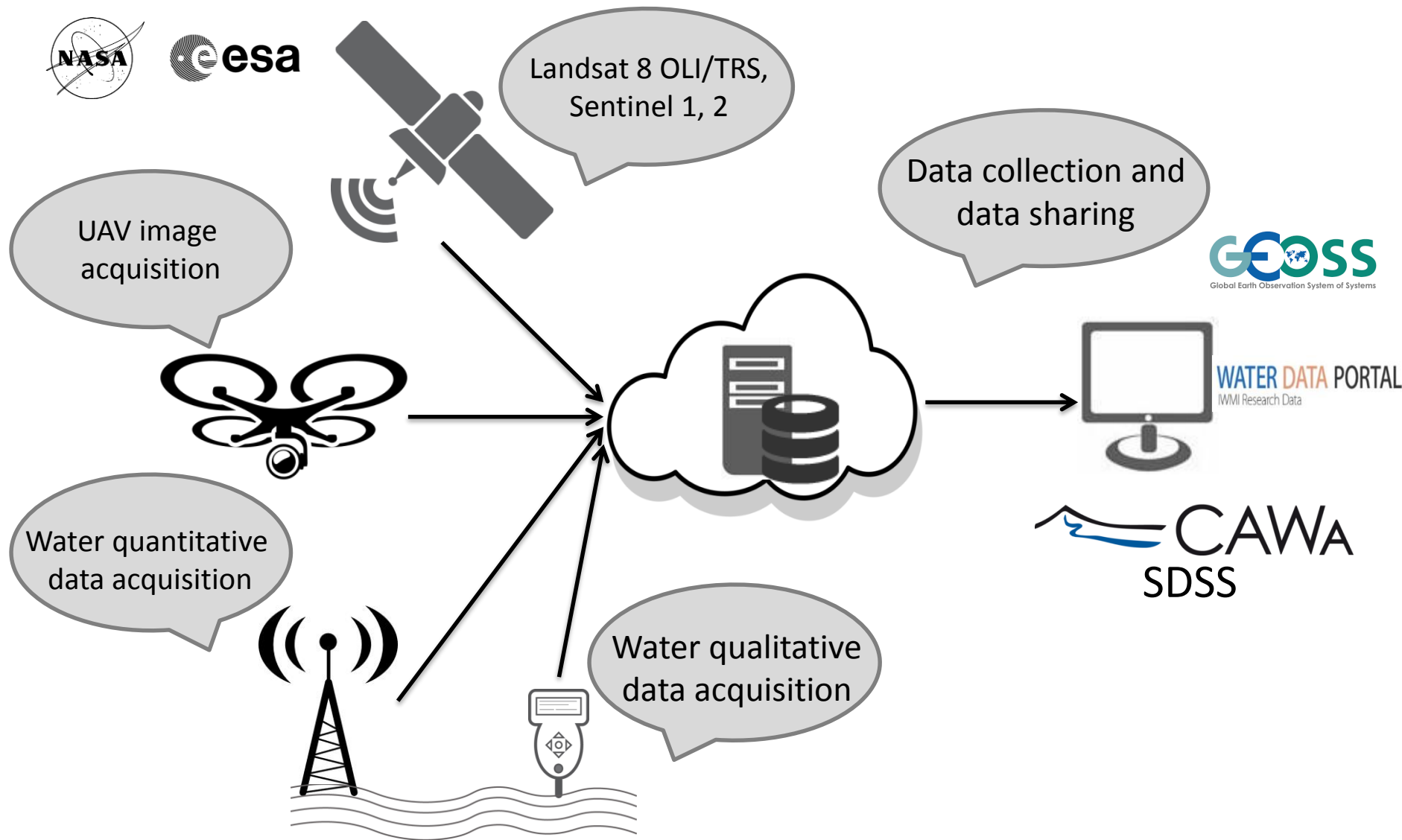
Design and implementation of Transboundary Water Earth Observation System (TWEOS) able to analyze continuous flow of data and present the results to stakeholders.

- Data standardization: adopting international standards (GEOSS, INSPIRE) to share and distribute services through web services. Defining data access rights and distribution policy.
- Technical training through a joint workshop on implementing best practices for data standardization and sharing, metadata management, and GEOSS.
- Exploring CAWa Sensor Data Storage System (SDSS), assuring the synergy between two programs.
- Exploring GRASS GIS and QGIS tools and developing a set of new workflows (remote sensing and hydrological models) on OGC WPS standards, which will complement IWMI's Water Data Portal (WDP) data visualization and processing capabilities in a distributed environment.
- TWEOS development offering access to the data types needed for water monitoring, control, decision making, remote -hydrological modeling and water management.

Improve national and international networking with key institutions and programs, by being active in international Initiatives such as Group of Earth Observation (GEO).

- Registration of the spatial datasets and metadata into GEO-portal.
- Conducting an international scientific workshop by inviting key national, regional and international experts in SDI, GEOSS and geocomputation to highlight the benefits of the methodology and research results.
- Dissemination of results in GEO Plenaries and annual events.

Transboundary Water Earth Observation System (TWEOS) development methodology



Participating organizations description and expertise



CENS has implemented a number of national and international project. In particular, CENS has coordinated a **EU FP7** EcoArm2ERA project and “The South Caucasus River Monitoring” regional project funded by **NATO Science for Peace** program. Besides, CENS participated in a number of projects as an associated partner (i.e. **FP7 TURAS project, FP7 EOPOWER project, FP7 EnviroGRIDs**, etc).

Presently CENS is a partner of a **H2020** CONNECTING project consortium recently funded by European Commission.

It should be mentioned that in frame of several national projects CENS is developing **RS methods for assessing and monitoring ecological state** of lake waters (a case: Lake Sevan) and agricultural crops.

CENS is also a coordinating body of the national **GEO** activities in Armenia.



The International Water Management Institute (IWMI) has been doing research on water for the last 30 years. Being a non-profit research organization all the research. In particular, IWMI’s research in the region focuses on identifying best practices for saving water, improving irrigation performance, reversing trends in land degradation and salinity, and contributing to the development of effective water resource institutions. In the past, IWMI was also active in developing transboundary dialogue on two pilot rivers shared by three states: Kyrgyzstan, Tajikistan and Uzbekistan.

During 2001 and 2002, IWMI established its formal partnerships with the International Center for Agricultural Research in the Dry Areas (ICARDA), Scientific Information Center of the Interstate Commission for Water Coordination (SIC-ICWC), the Central Asia chapter of the Global Water Partnership (GWP), and the Tashkent Institute of Irrigation and Melioration (TIIM).

IWMI also maintains close relationships and collaborations with other important development partners in the region, such as the Asian Development Bank (ADB), World Bank (WB), Swiss Agency for Development and Cooperation (SDC), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and others.

KazSRIWE

KazSRIWE is a leading scientific organization in the field of water management, melioration, irrigation and its technologies, agricultural water supply and pasture and water economy in the Republic of Kazakhstan.

Projects:

- ✓ Scientific provision of rational use of water resources and development of technologies for land reclamation (2015-2017 yy.)
- ✓ Development of water, chemical, biological and physical reclamation systems for increasing the productivity of water and land resources on irrigated lands in Kazakhstan (2015-2017 yy.).
- ✓ Development of enlarged norms of water consumption and water disposal (2014-2015 yy.)
- ✓ Estimation of the dynamics of retrospective economic water consumption and long-term forecasting of economic demand for water (2015-2016 yy.) Customer: Institute of Geography. Cost - 60 000,0 US\$
- ✓ Development of design estimates for the installation of an automated control system Aktobe reservoir in the Aktyubinsk region (2016-2017 yy.)
- ✓ Development of scientific and technical measures to determine the degree, type, area of pollution and the volume of cleaning the bottom of Lake Bilikol in the Zhambyl region,
- ✓ and others.

Expected results and their application

Major results expected from the project implementation will be a development of **Transboundary Water Earth Observation Monitoring System (TWEOS)** including:

- a designed **network of remote automated hydrological stations**, which will provide real time information about water quality and quantity.
- a produced **joint database of spectral signatures and characteristics of ecological status of water** in transboundary basin of the Syr Darya River.
- a developed **time- and cost-efficient RS method of the assessment of ecological state of river and lake water**, which will serve as a key tool for developing a water observation system for monitoring transboundary rivers basins and water bodies.
- a created **Environment Oriented Satellite Image Processing Platform** based on IWMI's WDP which will include a set of tools for the remote monitoring of quantitative and qualitative parameters of transboundary rivers and water bodies.

The project's sustainability and influence on the progress in this area

The successful implementation of the activities will considerably enhance and increase the regional and interregional coverage of Armenian, Kazakh and Uzbek partners as well as their research and technological performances and will promote close collaboration between scientists and policy-makers in this field. Noteworthy, the EO4WMAN has a close interconnection with CAWa project, which comes to complement CAWa's tools of data processing and visualization.

The RS hydrological models to be developed in the frames of the proposed project will help resolve conflicts related to specificities of transboundary water use. Eventually, the project results may then be used to study ecological situation on the territories of other transboundary basins.

At the end of the project a series of training sessions will be organized for the state monitoring specialists and the Standard Operational Procedures (SOPs) will be transmitted to the relevant organizations for further operations.

Role of Foreign Collaborators/Partners

- Optical Remote Sensing data (Landsat, Sentinel) analysis and harmonization (NASA).
- Radar data analysis (ESA).
- In-situ hydrological station network design, Data standardization data sharing (GFZ, UNIGE).
- All foreign collaborators will participate in semi-annual project review meetings. Most of them will help in organizing the joint workshops.

Meeting ISTC Goals and Objectives

- Alternative work of the specialists from the CENS, IWMI, KazSRIWE, earlier engaged in **defense R&D activity**.
- The project also involves the **young specialists the graduates** of higher educational institutions of Armenia, Kazakhstan and Uzbekistan.
- Solve the task not only significant for **science and technology** in general, but also connected to environmental issues, therefore directly linked to risk factors for **sustainable transboundary water management**.
- Reinforce the cooperation capacity of Armenian, Uzbekistan and Kazakhstan organizations by creating the possibilities to **improve its research and infrastructural activities** in the areas of thematic priorities.
- A state-of-the art online platform allowing remote monitor and model the **ecological state of the water bodies for our regions of interest (Central Asia)** by adopting an integrated approach including improved monitoring system, data management, data processing and research.
- Supporting and **developing fundamental and applied studies** in the area of ecological technologies and safety for peaceful purposes

Thank you